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POWERED WHEELCHAIRS

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ABSTRACT

This document gives information about the usage of wheelchairs based on renewable energy systems. The renewable energy systems which are discussed in this paper are batteries and solar panels. It also gives a report on the efficiency and durability of batteries and solar panels. Explanatory material is followed by a worked example and problems with answers.

KEYWORDS: Basic Powered, Wheelchair to Wheelchair

INTRODUCTION

There are two basic types of wheelchairs: Manual and Powered Wheelchairs. Manual wheelchairs are designed to transport a sick, injured or a disabled person from one place to another, e.g.: in hospitals. A Powered wheelchair uses a motor attached to the wheelchair. A 1993 report prepared by Rehabilitation Engineering centre suggests that the selection of wheelchairs depends on one's physical status, functional capabilities and usage requirements.

WHEELCHAIR COMPONENTS

Basic powered wheelchair components have many similarities to those found on manual chairs. However, others such as batteries, controllers and drive systems are unique to powered wheelchairs.

Frames

Traditional-style chairs now have frames made of steel, cold-rolled steel, tubular steel, chrome-moly, and aluminium. Power base chairs may have aluminium, stainless steel, cold-rolled steel, flat steel, tubular steel or steel frames. Many traditional-style models utilize the traditional cross-brace frame which allows the chair to be folded. Other traditional models and some power base chairs disassemble for transport.

Upholstery

The upholstery of a wheelchair should be such that it can withstand all types of weather and can allow daily use. Consequently, manufacturers provide a variety of options to users, ranging from cloth to new synthetic fabrics to leather. Many manufacturers also offer a selection of upholstery colors, ranging from black to neon, to allow for individual selection among consumers.

The other important components of wheelchairs are:

- **Seating Systems:** To be chosen on individual basis.
- **Brakes:** Powered wheelchairs utilize a dynamic braking system in which the motor and brakes work together to slow and stop the chair and also engage the brakes when the power is off.

- **Wheels/ Tires:** All wheelchairs generally use the standard four-tire configuration, with two large tires and the front and two smaller ones called casters at the back of the wheelchair.
- **Footrests:** A variety of footrests are available for both types of wheelchairs like rigid single unit, detachable, flip-up etc
- **Armrests:** They are also available in various sizes and with a combination of features. They may be full or desk-length and they may be fixed or removable.
- **Controls:** Powered wheelchairs consist of a manually controlled joystick to control their speed and direction.
- **Drive System:** It refers to the means by which power is given to the wheels of the wheelchair.

TYPES OF WHEELCHAIRS

- **Basic:** Durable medical equipment. Seat width options of 16, 18 or 20 inches.
- **Narrow:** Typically 16 inch wide seat only.
- **Standard:** The basic model with additional features like elevating leg rests and detachable footrests.
- **Light-weight:** For those who travel with their wheelchairs.
- **Extra-wide:** Normal wheelchairs have a weight capacity of 300lbs,the extra-wide wheelchairs range from 350 to 450lbs maximum weight capacity
- **Antimicrobial:** These wheelchairs work continuously to slow or prevent the odour or stain causing bacteria.
- **Bariatric:** Such wheelchairs can support up to 700 lbs.

The other types of wheelchairs include heavy duty transport wheelchairs and wheelchairs for children.

EXPLANATORY EXAMPLE

Case 1: Manual Wheelchairs

Let us assume that our wheelchair weighs =20 KG

Let the weight of the person sitting in the wheelchair=70KG

Therefore,

Total weight of the wheelchair =weight of wheelchair + weight of person = 20KG+70KG=90KG

Assume average walking speed of a person= 6 km/hr

= (6*5)/18=1.67m/s

Let the initial time for the chair to move (t) =5 sec

The force required to push the chair on a flat surface

= (total weight*speed)/time

= (90*1.67) / 5 = 30.06N (1)

A minimum force of 30.06N would be required for the movement of the wheelchair over a flat surface

Power required = force*distance covered per second

= 30.06 * 1.67 = 50.2W (2)

Every two objects in contact in this world would suffer from friction between them. Just how much friction can be generated by the relationship of a tire and road is defined by the following equation: **F=μN**

Coefficient of friction μ=0.6 (rubber on dry concrete)

F=0.6*30.06 =18.036N (3)

Power required = force*distance covered per second

= 18.036 * 1.67 = 30.12W (4)

Total power= 50.2W+30.12W {from (2) and (4)}

=80.32W (5)

Now, if an electrically powered wheelchair is used in this case, then a 80-180W motor should be used. One of the batteries used in this motor could be a 24V 5ah.

Assume the weight of the battery=5KG

Total weight of the wheelchair=90KG+5KG=95KG

Force required = (95*1.67)/5

= 31.73N {from (1)}

Power required = 31.73 *1.67

= 52.98W {from (2)}

Total power = 52.98+31.79 (including friction)

=84.77W {from (4)}

We know that Power = VI

Therefore, I = 84.77 / 24 {from (5)}

= 3.53A (6)

Number of hours the battery would last once charged

= 5 / 3.53

= 1.41 hours.

Case 2: **Powered Wheelchair on an Inclined Ramp**

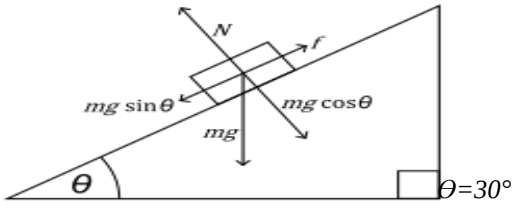

Figure 1

Total weight of the wheelchair=weight of wheelchair + weight of person= 20KG+70KG= 90KG.

Force required in moving the wheelchair on a 30° ramp

= total weight * gsinϴ

= 90*9.81*sin30

=441N (7)

Power required = force *distance covered per second

= 441 * 1.67

= 706W (8)

F= 0.6*441*cosϴ {from (3)}

= 229.15N

Power required=229.15*1.67 {from (4)}

=383W (9)

Total power= 706W+383W

= 1089W

Now, if a 1150W motor is usedthen, one of the batteries used in this motor could be a 24V 65ah.

Assume weight of the battery =5KG

Total weight of the wheelchair=90KG+5KG=95KG

Force = 95*9.81*sin30 =466N from (7)}

Power required = 466*1.67 = 778.2W {from (8)}

Total power = 778.2+404.37 = 1182.57W (including friction)

We know that Power = VI

Therefore, I = 1183/24

= 49.29A

Number of hours the battery would last once charged

= 65/ 49.29

=1.31 hours(for wheelchair moving continuously on a ramp)

As seen from the above example, a 24V 65ah battery, if used would last only for about an hour .Hence, there should be proper selection of batteries.

The different types of available batteries are:

- **Wet Cells:** These are heavy weight batteries which contain liquid sulphuric acid. Also, there is a possibility of leakage which is hazardous but if maintained properly these can be used the longest.

- **Dry Cells**
    - **Nickel-Cadmium:** These cannot be used since they cannot be manufactured in different sizes and on reusing them, the output becomes lesser.
    - **Lithium Ion:** Preferred more over Ni-Cd batteries because they can be made of any size and are rechargeable.
- **Gel Cell and Glass Matt Batteries:** In these batteries, the electrolyte does not evaporate and so it NEVER needs to be replaced. Gel cell batteries have a greater resistance to cold weather but glass matts can withstand high temperatures. Glass matt batteries have high power density and are preferred for high performance electric vehicles.

SOLAR POWERED WHEELCHAIR

In order to improve the power of the chair, Australian Bob Triming decided to add a solar panel system to the chair. He added two 20W panels that served up to 24Vto the chair, thereby giving the chair an additional 30 min of charge.

- **The Problem**
    - 24V chair, only solution: Solar
    - Small solar: 12V DC
    - Can be used only when the sun is shining.
- **Solution**
    - Use a 12V system to charge a 12V battery.
    - Use an inexpensive and efficient inverter to power an efficient 24V DC battery charger.
- **The Result**
    - The solar panels charge the panels during the day while the wheelchair is being used.
    - The 12V battery supplies and inverter to an efficient 24V battery charger at night, charging the wheelchair batteries.

MANUAL WHEELCHAIR V/S POWER WHEELCHAIR

Manual Wheelchair

- Light-duty chairs do not provide much in terms of support, and rarely provide the means to adjust the chair to the user. As a basic wheelchair to use if the user wants to take a break from walking, this is the most cost effective choice.
- Heavy-duty chairs solve many of the comfort and adjustment issues that light-duty chairs lack at the expense of some compactness. These types can be had with seat cushions and hard backs which greatly increase the comfort and support for the user.

Powered Wheelchair

- Front-Wheel Drive (FWD) chairs: The primary disadvantage to a FWD chair is the lack of stability when braking and travelling down inclines.

- Rear-Wheel Drive (RWD) chairs: used to be the 'typical' configuration for power chairs. This chair is ideal for outdoor purposes.
- Mid-Wheel Drive (MWD) chairs: came about as a compromise between FWD and RWD chairs. The idea of the MWD chair is to try and get the manoeuvrability of a FWD chair with the stability of a RWD chair

CONCLUSIONS

Any kind of battery, if not properly charged and maintained, cannot be used. The main characteristic of a wheelchair is its weight. Therefore, a battery and a motor is to b selected in such a way that the efficiency is not hampered and can be easily operated. Although solar panels prove to be a good source of energy, the primary disadvantage is the time it takes to charge the chair. If more charge is required, more number of panels needs to be fitted which in turn increase the weight of the wheelchair. Also, solar powered wheelchairs is not cost friendly.

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APPENDICES

Figure 2

Figure 3